SCHOFIELD BARRACKS MILITARY RESERVATION, KU TREE RESERVOIR, VALVE TOWER FOOT BRIDGE **HAER No. HI-81-C**
Kalakoa Stream
East Range
Wahiawa Vicinity
Honolulu County
Hawaii

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Department of the Interior
1849 C Street, NW
Washington, D.C.

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Location:	Kalakoa Stream (Tributary to the South Fork of Kaukonahua Stream) Approximately 3 miles east of Wahiawa East Range, Schofield Barracks Military Reservation City and County of Honolulu Hawaii USGS 7.5 minute series topographic map, Waipahu, HI 1998 Universal Transverse Mercator (UTM) coordinates: 04.605690.2377500.
Date of Construction:	1922-1925
Engineers & Builders:	Office of the Quartermaster General and Office of Chief of the Fourth Construction District
Present Owner:	U.S. Army
Present Occupant:	U.S. Army (training area)
Present Use:	Unusable, only concrete and metal elements remain.
Significance:	The valve tower pedestrian bridge is significant as an element of the Ku Tree Reservoir and as a good example of a valve tower bridge constructed in Hawaii in the 1920s. It is a rare example of a foot bridge with a suspension bridge portion constructed in Hawaii during the early twentieth century. The Ku Tree Reservoir foot bridge's concrete towers made its pedestrian suspension bridge one of the more imposing of this type constructed in Hawaii.
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Date:	June 2008

For additional information see the main report on the Ku Tree Reservoir (HAER No. HI-81), as well as the individual reports on the other related structures in this complex (HAER Nos. HI-81-A, HI-81-B, and HI-81-D).

DESCRIPTION

The foot bridge that accessed the Ku Tree Reservoir's valve tower now stands in ruin. It was comprised of two portions, an eight-span approach bridge about 80' in length, and a suspension bridge approximately 73' long, including the platform with the cable supports. These portions are no longer passable, as the deck of the approach bridge is not extant and only reinforced-concrete elements associated with the cable assembly remain of the suspension bridge.

The southern end of the elevated approach bridge portion was constructed on a knoll to the east of the dam. The approach bridge originally had a wood deck, supported by 6" steel channels bolted to 8"-square reinforced-concrete posts spaced 10'-0" on center. The deck and supporting channels no longer exist, but the eight pairs of concrete posts remain, with each pair joined near the bottom by an 8"-square reinforced-concrete beam. Originally the deck was made of 2 x 6s, approximately 4' in length, placed across the supporting channels and spaced 6½" on center. The concrete posts sit on 2'-0"-square spread footings and vary in height in accordance with the terrain, and most were partially submerged when the reservoir was near capacity. The posts rise 4'-6" above the level of the deck, and a pair of 1½"-diameter pipes, set 2'-0" apart, serve as railings. The upper railing is 4'-0" above the deck. These pipes still remain, running through holes in the concrete posts. The posts are eroded where the waterline fluctuated frequently. Sheet 30 notes that the maximum load for the bridge was 1,000 pounds.

The approach portion terminates at a platform whose tower supported the suspension bridge cables. The platform is 10'-2" beyond the approach bridge portion's last set of posts and set at about a 105-degree angle to the approach bridge. The 8'-0" x 6'-4" platform is framed by 8"-square reinforced-concrete posts tied together by similarly sized concrete beams located at three elevations: the tower's top, the platform floor, and 9'-0" below the platform's floor. There are also two diagonal braces of concrete, not shown on the 1924 drawings, on the north and south sides of the tower, between the west corners at the platform beams to the east corners of the ones below. The platform's wooden deck was made of 2 x 6s, spaced the same as on the approach bridge's deck. The platform's tower rises about 10' above the platform floor, with each of its four posts capped by 18" sheaves (mounted in journal boxes) through which the suspension cables ran. A similar sheave assembly, 66'-7" from the platform tower, sat on top of the valve tower, inside the operating room. This sheave support tower, on top of the valve tower, had only two concrete posts. The suspension bridge had a pair of 1"-diameter steel cables which ran through the sheaves and were secured at their ends to concrete anchor pads with turnbuckles and eyebolts.

The west anchor block is level with the ground and measures 8'-0" in length and 7'-0" wide; the original drawings show its stepped base extends, at the deepest part, 5'-0" into the earth. The east anchor block is 7'-0" square and its depth is 5'-6"; a portion of the block's top extends above the ground, due to the manner in which the cable entered this anchor. It is located approximately 148' from the tower on the top of a hill, which became an island when the reservoir contained water. The west anchor block is situated about 28' behind the platform. All structural portions (cable supports and anchor blocks) of the suspension bridge are aligned along a single axis. The anchor blocks still remain, along with the rusted remains of their turnbuckles and eyebolts, and sections of "wire rope" or cable.

The suspension bridge ran from the platform above the reservoir waters to the valve tower. Parallel steel cables ran from the anchor blocks up to the sheaves mounted on the platform and valve tower, and hung over the reservoir water in a curve with a 6'-8" sag at its low point. The cables supported the suspension bridge, using ½"-diameter rods as hangers spaced 5'-0" on center. The bridge had eleven sets of cable hangers (varying in height from 4'-7" to 11'-0") connected to 6" steel channels, each measuring 5'-4" and set perpendicular to the axis of the bridge. These supported longitudinal 6" channels, and both channels were bolted to vertical 3" angles. The deck and the railings were 2 x 6 boards. Diagonal cross-bracing provided additional stability below every other section near the center of the suspension bridge. The design allowed for a 4" camber in the bridge.

The foot bridge was already deteriorated and the deck of the suspension portion gone by 1978, when the first inspection report on the dam was prepared. (C-E Maguire, Inc. 1978: 13 and photo 7). By the time the reservoir was drawn down in 1983, the suspension cables had broken (Walter Lum & Associates, 1983: 38).

The valve tower bridge has lost much of its integrity with the bridge decks no longer extant and the suspension bridge's cables no longer in place. However, the bridges' concrete members and some metal elements remain intact, and from their presence the bridges' original design can be conceived by the trained eye.

HISTORICAL CONTEXT

The suspension bridge is one of the oldest types of bridge to be found in human history. With the development of wire cables in the nineteenth century the modern version of this ancient form became increasingly used by engineers in Europe and the United States for both pedestrian and larger vehicular bridges. In all likelihood it was selected for use as the Ku Tree Reservoir's valve tower bridge because it required fewer materials in its construction than other types of bridges. It may have also been chosen for its ease of construction, considering it spanned the almost 100' deep valley between the dam abutment and the valve tower.

The 1919 conceptual plans (Sheet 3) for the reservoir called for a concrete foot bridge to the valve tower, rather than the bridge with a suspension portion that was erected. Most likely, ease of construction plus lower cost and materials were factors which led to the selection of the suspension bridge as a suitable alternative. The final plans (Sheets 29-31) for the valve tower's foot bridge, with approach and suspension portions, were drawn and traced by W.F.J. in June and July 1924. The "Erection Diagram and Steel Details" (Sheet 32) for the suspension bridge portion were drawn by G.N. in July 1924.

The only two other known extant examples of pedestrian suspension bridges in Hawaii are the Hanapepe Swinging Bridge (1911, rebuilt 1992) crossing the Hanapepe River, and the Waimea Swinging Bridge (rebuilt 1996) crossing the Waimea River, both on Kauai. These two extant Kauai bridges are more modest in their design than the Ku Tree bridge, and their structural elements are made of wood.

This foot bridge is typical of its period in its use of materials, method of construction, craftsmanship, and design. The design of the bridge and its method of construction for the suspension portion followed a standard approach, first published by James Finley of Pennsylvania in 1796, with anchor blocks, towers, catenary system, and a level deck supported by hangers (Burr and Falk, 1905: 26). Its towers supported the vertical load, or compression, of the bridge, and the concrete anchor blocks maintained the tension in the cables. The bridge's use of reinforced concrete for its structural supports was uncommon in Hawaii, but more widely used in the mainland United States, having become a popular building material during the opening decades of the twentieth century. The bridge's now rusted "wire rope" was typical of the period by not being pre-stressed. They were some of the last such cables used in a suspension bridge, as in 1928 Roebling Company developed pre-stressed cable for suspension bridges, and the material quickly became the norm in bridge construction from that point forward as it assured more reliable load calculations.

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PROJECT INFORMATION

See main report for Ku Tree Reservoir, HAER No. HI-81.

Figure 1: Suspension Bridge to Valve Tower, Ku Tree Reservoir. Job S3603, Sheet 29, dated June 1924.